2011 Clear Creek Technical Team Report for the
OCAP BiOps Integrated Annual Review
Prepared by Matt Brown, FWS, Red Bluff
October 7, 2011

Brief Background on Clear Creek and the Technical Team:
Since 1995, CVPIA and later CALFED have undertaken extensive habitat and flow restoration in Clear Creek (See map on page 11). The restoration has increased stocks of fall Chinook 4 fold and re-established populations of spring Chinook and steelhead. The Clear Creek Technical Team (CCTT) has been working since 1996 to facilitate implementation of CVPIA anadromous salmonid restoration actions. Team membership has varied over the years depending on what topics are being covered in the meetings. The majority of the topics have involved physical habitat restoration funded by CVPIA and CALFED.

Active Members:

Russ Weatherbee, Whiskeytown National Recreation Area
Naseem Alston/Bruce Oppenheim, National Marine Fisheries Service
Matt Brown, U.S. Fish and Wildlife Service
Tom Kisanuki, Bureau of Reclamation
Gary Diridoni, Bureau of Land Management
Tricia Bratcher/Eda Eggeman/Andrew Jensen, California Department of Fish and Game
Aric Lester, California Department of Water Resources
Guy Chetelat, Regional Water Quality Control Board
Ryan Teubert, Western Shasta Resource Conservation District
Alicia Young, Point Reyes Bird Observatory
Several consultant groups attend as needed

Summary of RPA Actions:	**Progress in FY 2011?**
• Spring Attraction Flows	Yes
• Channel Maintenance Flows	Yes
• Spawning Gravel Addition	Yes
• Replace Temperature Curtain	Yes
• Thermal Stress Reduction	Yes / No
• Adaptively Manage to Habitat Suitability / IFIM Study Results	Yes
• Other RPA required monitoring and operations	Yes

Summary of Clear Creek Team Meeting OCAP Related Discussions. The following list is of topics that were covered in CCTT meetings. The list does not include non- OCAP habitat restoration topics. Items with asterisks* involve NMFS BO RPA required monitoring.

December 16th:

Summary of OCAP BO Annual Review and CCTT Presentation
Gravel Project Evaluation Annual Report to NMFS. Presented results and solicited recommendations for report required in Action I.1.3.
2010 Spring Chinook Survey and Segregation Weir*

January 27th

Spring Pulse Flows. Planning and coordination for Action I.1.1.

Channel Maintenance Flows. Status update for Action I.1.2.
Monitoring Weir Decision Making*

March 24th

Recommendations for Instream Flow and Water Temperature for Salmonids in Clear Creek. Presentation from Li-Ming He of NMFS on his draft proposal related to Actions I.1.1. I.1.2. I.1.5. and I.1.6.
Spring Pulse Flows and June Ramping Rate. Planning and coordination for Action I.1.1.

June 23rd

Spring Pulse Flow. Results for Action I.1.1.
Rotary Screw Trapping Results*

July 20th

No OCAP related discussions

September 22nd

Scorecard / Summary for OCAP BO Annual Review Report and Presentation
Requesting Recommendations for Annual Gravel Evaluation Report for NMFS BO (Action I.1.1.)
Role of Clear Creek Technical Team in Clear Creek pulse flow, temperature management and NMFS OCAP BO RPA (Actions I.1.1. and I.1.5.) Brief discussion needing follow-up.
Clear Creek Environmental Water Program Workshop. Announcement for Action I.1.2.
Fish Monitoring - Spring Chinook Index, Decreased Juvenile Productivity, developing new size specs for gravel for restoration projects*

Summary of CVP Operations

Releases from Whiskeytown into Clear Creek in water year 2011 started at 200 cfs and continued until May 12 when flows were adjusted to 175 cfs in anticipation for pulse flows which occurred in the following 4.5 weeks (see Action I.1.1.). After the pulse flows, 175 cfs releases were gradually reduced in 10 cfs increments over 2.5 weeks to 125 cfs. Flows were increased from 125 cfs to 225 cfs over 6 days starting on September 14, in an attempt to reduce water temperatures to less than 56 degrees at Igo (see Action I.1.5.).

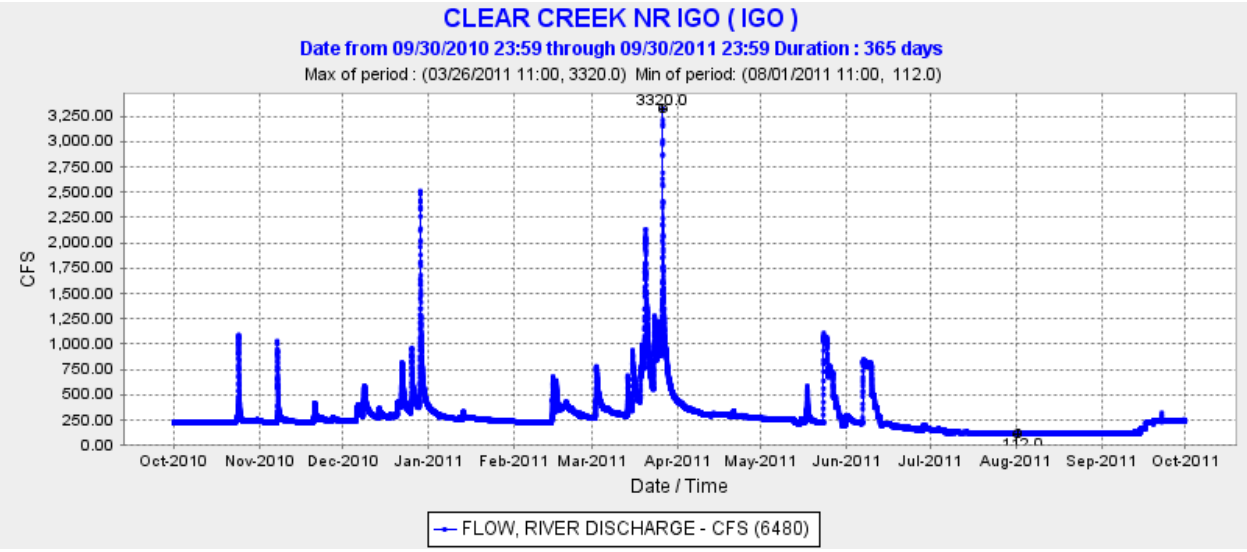


Figure 1. WY 2011 annual hydrograph at the Igo gage on Clear Creek based on 15 minute data.

Action I.1.1. Spring Attraction Flows

Objective: Encourage spring-run movement to upstream Clear Creek habitat for spawning.

Action: "Reclamation shall annually conduct at least two pulse flows in Clear Creek in May and June of at least 600 cfs for at least three days for each pulse, to attract adult spring-run holding in the Sacramento River main stem. This may be done in conjunction with channel-maintenance flows (Action I.1.2)". In 2011, an 800 cfs release was attempted

Results: Two pulse flows were provided between May 23 and June 12, 2011 (Figures 1 and 2). Results from the 2010 spring pulse flows suggested that more than 600 cfs can be released from Whiskeytown Dam while allowing the Clear Creek Community Service District to receive water from Whiskeytown. These higher flows may be useful 1) in removing the large amounts of fine sediment which have recently increased in Clear Creek due to catastrophic wildlife that occurred in 2008, and 2) in moving stockpiled spawning gravel downstream to create spawning habitat. Therefore in 2011, higher releases of 800 cfs were attempted to determine the highest releases available while allowing other users to access water from the Whiskeytown Dam. Flows at the Igo gage of more than 1,000 cfs were sustained during the experiment. The difference in the targeted and achieved flows was not due to tributary flow or accretions. This difference is consistent with previous results suggesting that the rating curve for the Whiskeytown outlet works underestimates discharge during high releases. In this case the underestimate was more than 200 cfs.

The pulse flows were successful in moving gravel downstream from 2 supplementation sites in the reach just downstream of Whiskeytown Dam, where flows are rarely high enough to move gravel. Preliminary data suggests that large amounts of sand were transported during the pulse flows. Therefore the pulse flows were successful in the secondary objectives of moving gravel and fine sediment.

As in 2010, fish monitoring results in 2011 were inconclusive due to low adult counts. Snorkel surveys counted one spring-run Chinook before the pulse flows, two after the first pulse flow and 9 after the second pulse flow. The August count which is used as the population index was 8 Chinook. In 2010 the counts were 1, 10, 11 and 21 respectively. The August Spring-Run Index was again less than expected; counts in the previous three years were 194, 200 and 120. Due to the low number of spring Chinook and redds, performance evaluation was confounded because a change in one fish would greatly change measures of success for most performance measures. Performance measures included the percent change in counts of Chinook between snorkel surveys, the distribution of spring Chinook during the August Index and the distribution of redds at the end of the season. It is possible that the pulse flows may have negatively affected spring Chinook migration by an unknown mechanism.

Recommendations: Continue providing attraction flows similar in magnitude (800 cfs) and duration to 2010. Higher flows ($\geq$1,000 cfs) similar to 2011 should be considered if gravel is available to be effectively transported downstream. Consider the question "are flows negatively effecting spring Chinook migration?"

Figures:

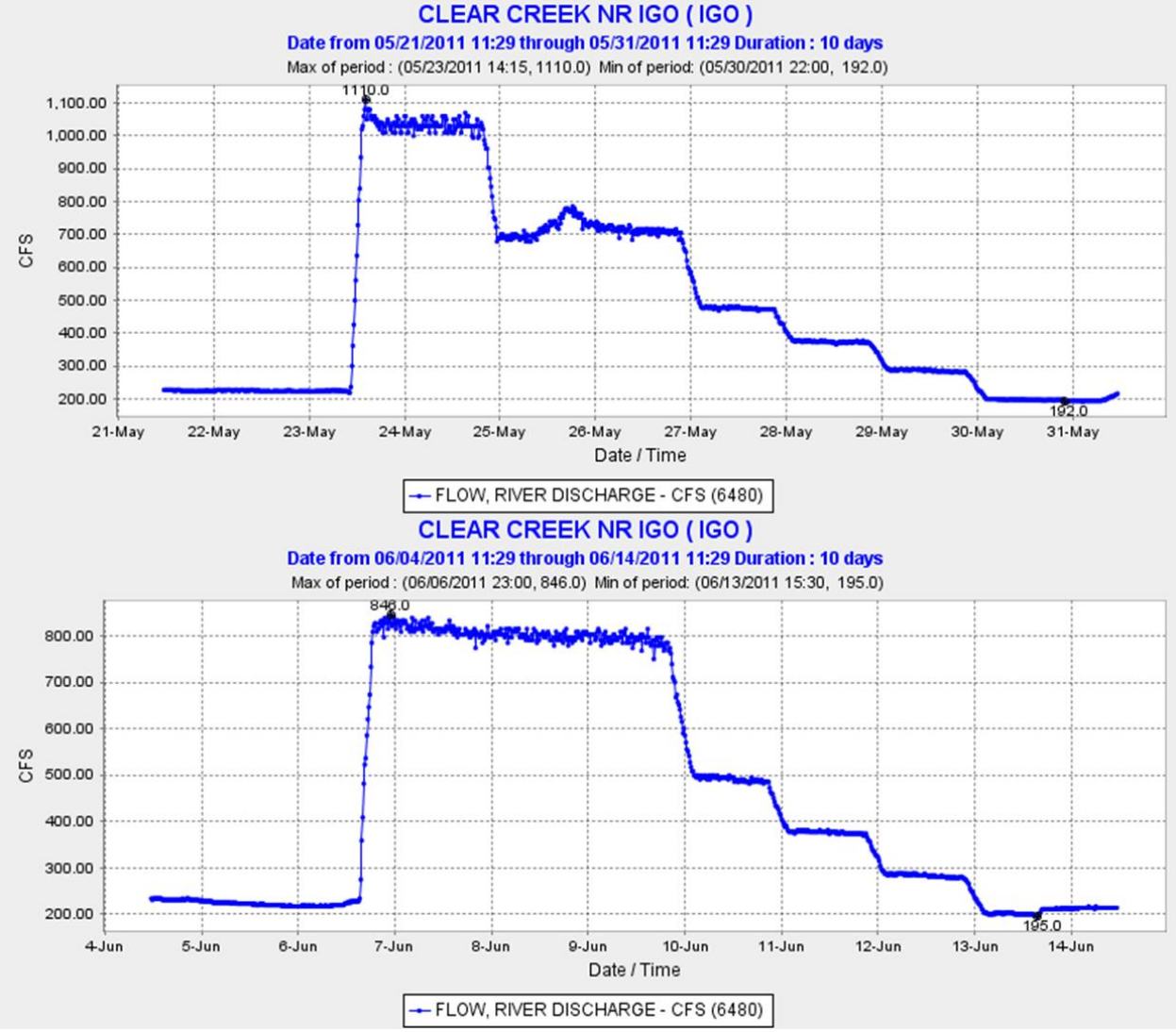


Figure 2. Discharge measured every 15 minutes at the Igo gage during May and June pulse flows 2011.

Action I.1.2. Channel Maintenance Flows

Objective: Minimize project effects by enhancing and maintain previously degraded spawning habitat for spring-run and CV steelhead.

Action: "Reclamation shall re-operate Whiskeytown Glory Hole spills during the winter and spring to produce channel maintenance flows of a minimum of 3,250 cfs mean daily spill from Whiskeytown for one day, to occur seven times in a ten-year period, unless flood control operations provide similar releases. Re-operation of Whiskeytown Dam should be implemented with other project facilities described in the Environmental Water Program (EWP) Pilot Program".

Results: This action has not been implemented yet. In 2008, CDFG awarded a contract to the FWS, in the amount of $813,745, to plan and implement a one-time re-operation of the type required in the RPA. Funding issues associated with the State of California's inability to pay, delayed the project for 3 years. The contract was finally signed in April 2011 and a 3-year time extension was approved. Subcontracts were developed and executed with Reclamation, ESSA Inc, Stillwater Sciences and Graham Matthews and Associates. A 3-day implementation workshop was held October 25 to 27, 2011 in Sacramento. The project timeline anticipates implementation of the flows in 2013.

Since 2008, juvenile productivity of spring Chinook, steelhead and fall Chinook has been reduced (Figures 3, and 4). Geomorphic monitoring indicates that the 2008 Moon Fire and subsequent salvage logging resulted in a large increase in fine sediment in salmonid spawning areas in Clear Creek. CVPIA's attempts to inventory and control erosion, and to physically remove sediment from the creek did not come to fruition in 2011. Channel maintenance flows may be the most cost effective and feasible method for removing fine sediment from spawning areas of Chinook and steelhead.

Recommendations: Reclamation and other agencies should continue discussions through the EWP Pilot Program.

Figures:

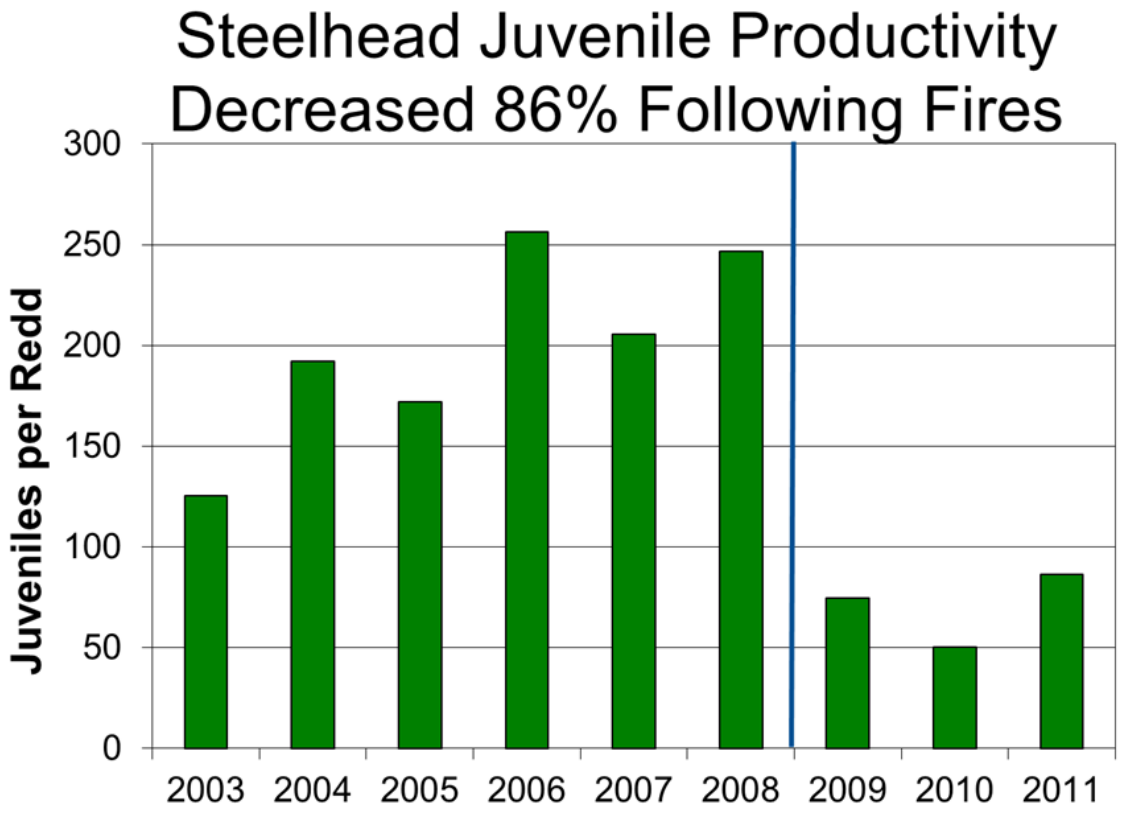


Figure 3. Annual estimates of juvenile productivity calculated as the number of juvenile O. mykiss juveniles passing the lower Clear Creek rotary screw trap divided by the number of redds observed during kayak surveys. The blue line indicates when the fires occurred.

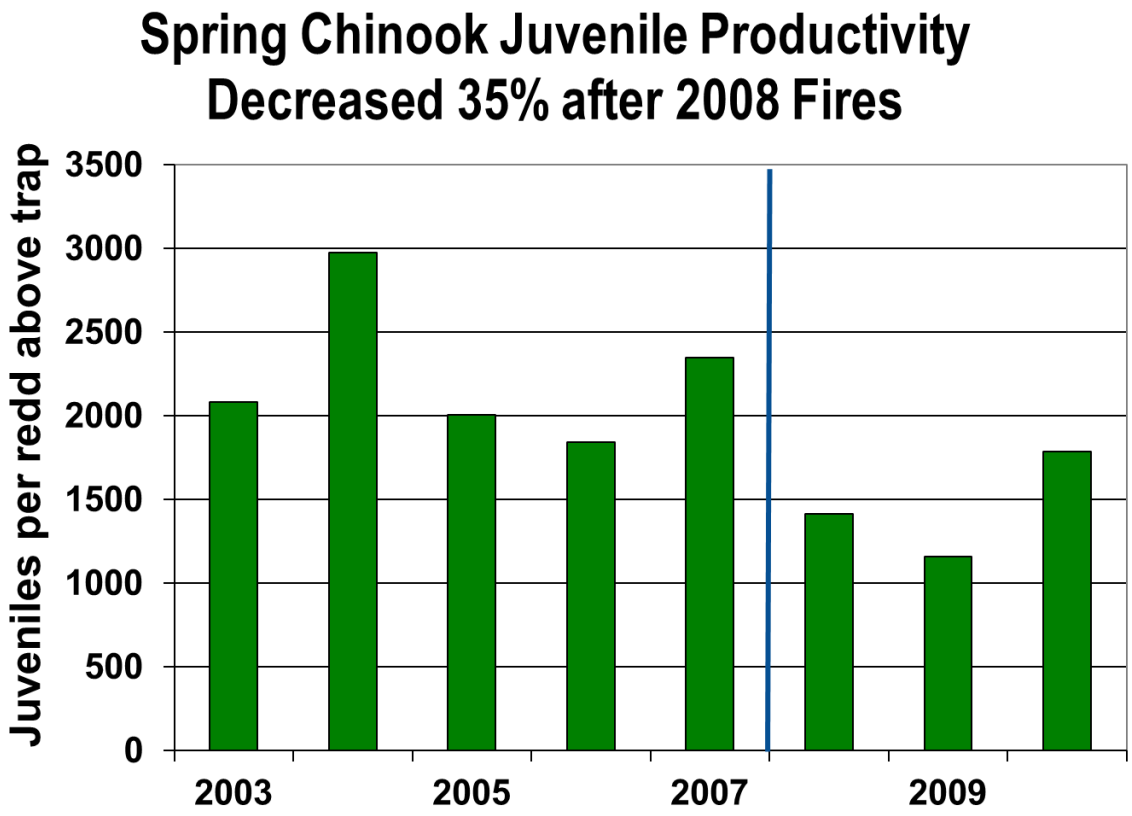


Figure 4. Annual estimates of juvenile productivity calculated as the number of juvenile spring Chinook juveniles passing the upper Clear Creek rotary screw trap divided by the number of redds observed during snorkel surveys. The blue line indicates when the fires occurred.

Action I.1.3. Spawning Gravel Augmentation

Objective: Enhance and maintain previously degraded spawning habitat for spring-run and CV steelhead.

Action: "Reclamation, in coordination with the Clear Creek Technical Team, shall continue spawning gravel augmentation efforts. By December 31 each year, Reclamation shall provide a report to NMFS on implementation and effectiveness of the gravel augmentation program".

Results: In 2011, 10,000 tons of spawning gravel was placed at 5 sites in the uppermost reach of Clear Creek. The table below shows locations and amounts of gravel added:

2011 Gravel Injections	
Location	**Amount (tons)**
Whiskeytown Dam	3,000
Below Dog Gulch	2,000
Above Peltier Bridge	1,000
Below Peltier Bridge (Paige Bar)	1,000
Below NEED Camp	3,000

Future Spawning Gravel Projects- CVPIA continued work on projects to provide a long-term supply of spawning gravel and provide long-term permits for placing it instream. CVPIA funded planning, design and permitting for a project to provide an inexpensive, long-term gravel supply for Clear Creek restoration. The project could provide gravel for 20 to 40 years with a fixed acquisition cost. In July, ERP decided to reconsider funding the project implementation if the proposal was revised. A revision developed with the assistance of the Clear Creek Technical Team was submitted and a decision is pending. The current cost estimate for implementation is around $4 million. This two year project could begin implementation in 2012 or 2013.

Spawning Gravel Evaluations- During 2011, FWS in consultation with the CCTT proposed that the gravel size specification used for gravel projects be modified. The changes were based on comparisons of sediment size measurements in gravel projects and in areas used for spawning by salmon and steelhead in Clear Creek. The new specification increases the proportion of material between 2.5 and 5 inches from 10 to 20% to 20 to 35%, and reduces the proportion between 0.5 and 2.5 inches from 60 to 80% to 25 to 50%. Another 2011 FWS study compared current amounts of spawning habitat to earlier studies that suggested that construction of Whiskeytown dam had reduced spawning habitat by 92%. Initial results suggest that much of that degraded habitat has been restored, although it will require gravel in perpetuity to replace that blocked by Whiskeytown Dam. The 2010 annual report to NMFS on implementation and effectiveness of the gravel augmentation program was written by the FWS for Reclamation.

Recommendations: Continue the following: 1) adding spawning gravel at existing sites; 2) incorporating new sites including method-types such as talus-cone injection, in-stream placement, lateral berms, and sluicing; 3) implementing and evaluating the new gravel size specification; and 4) providing controlled pulse flows like the spring pulse flows to move supplemental gravel into the creek and create spawning habitat.

Action I.1.4. Spring Creek Temperature Curtain

Objective: Reduce adverse impacts of project operations on water temperature for listed salmonids in the Sacramento River.

Action: "Reclamation shall replace the Spring Creek Temperature Control Curtain in Whiskeytown Lake by 2011". [This action was not implemented by the CCTT]

Results: Replacement of the broken temperature control curtain was intended to reduce the temperature of water diverted to the Sacramento River via the Spring Creek tunnel. The temperature curtain was designed to pull cold water from lower levels of Whiskeytown Reservoir. Reclamation awarded a contract to replace the curtain in September 10, 2010. The new curtain was installed by June 15, 2011. The project cost about $3M. Due to technical problems with monitoring equipment, pre-project monitoring was not conducted to evaluate the projects effectiveness in the Sacramento River. Although the objective of the project was to improve water temperatures in the Sacramento River, water temperatures should be an analyzed to evaluate the effect of the project in Clear Creek.

Recommendations: Evaluate the effectiveness of the temperature control curtain in reducing water temperatures in both the Sacramento River and Clear Creek. An evaluation could

determine if the curtain was installed successfully, if it is working as designed, if any improvements are needed or warranted, and how much benefit it produces in terms of cold water.

Action I.1.5. Thermal Stress Reduction

Objective: To reduce thermal stress to over-summering steelhead and spring-run during holding, spawning, and embryo incubation.

Action: "Reclamation shall manage Whiskeytown releases to meet a daily water temperature of:

1) 60°F at the Igo gage from June 1 through September 15; and

2) 56°F at the Igo gage from September 15 to October 31.

Reclamation, in coordination with NMFS, will assess improvements to modeling water temperatures in Clear Creek and identify a schedule for making improvements."

Results: As in previous years, the 60°F water temperature requirement was achieved 100% of the time between June 1 and September 14 (Figure 5 and Table 1). However, the 56°F water temperature requirement was achieved only 15% of the time between September 15 and October 31 [3 days achieved, 17 days not achieved by October 5th- this data will be updated at the workshop]. 2011 was the third year in a row where temperature targets were not achieved in a majority of days. This was particularly surprising in light of relatively cool summer air temperatures, wet water year conditions and very good water temperature conditions in both the Sacramento and Trinity rivers. Water temperatures at the Whiskeytown outlet were compared for the last 6 years. While the temperature targets were achieved in 2006 through 2008, they were not met in 2009 through 2011. To some extent these higher temperatures may have been due to reduced diversions from the Trinity River during the summer in the last 3 years. However in 2011, 18% and 44% more water was diverted than in 2009 and 2010, respectively, from June through September. In both 2007 and 2008, water temperature targets during spawning were met 98% of the time with only 10% more water and during dry water conditions. It is unclear why the first three years were successful and the second three years were not. It is unclear how operations could be modified to improve water temperatures.

Reclamation has not identified a schedule for making improvements to modeling water temperatures in Clear Creek. Reclamation has not fully assessed improvements to modeling water temperatures in Clear Creek. At least conceptually, improved water temperature modeling could improve CVP operations to meet current temperature targets. The model could consider tradeoffs in storage volumes and cold water pools in Trinity, Whiskeytown and Shasta reservoirs. Some aspects of Whiskeytown Reservoir temperatures are not well understood. For instance, water temperatures can rise quickly at rates up to 1 degree in 4 days (Figure 5, Sept 15 to 19 2009) during the critical spawning period for spring Chinook. During this period, eggs are the most sensitive to high water temperatures which can result in mortality. Understanding when and why this sudden warming of outflow temperatures occurs and changing operations to avoid it should be a high priority. In addition, improved temperature modeling could be used to evaluate and manage: 1) rearing temperatures for juvenile spring Chinook and steelhead in the lower creek. Recently more steelhead are spawning in the lowest reach of the creek where juveniles can be subject to high water temperatures during the summer. The current temperature

control point is 9.2 rm upstream at Igo (Figure 5); and 2) holding temperatures for spring Chinook holding downstream of Igo. On average, 51% of spring Chinook have been distributed downstream of the Igo Gage temperature control point. These fish and eggs were exposed to suboptimal water temperatures which can affect the viability of eggs and potentially resulting in mortality.

Recommendations: Develop a schedule for improving water temperature modeling to better meet Clear Creek water temperature objectives. Implement the findings that will result in temperature improvements. Consider managing water temperatures further downstream of Igo down where the majority of target fish are located.

Table 2. Proportion of days that water temperatures at Clear Creek Igo gage met targets.

	From	To	Target	Average 2001 to 2008	2009	2010	2011
Holding	01-Jun	14-Sep	60° F	99%	100%	100%	100%
Spawning	15-Sep	31-Oct	56° F	93%	**28%**	**26%**	**15%**

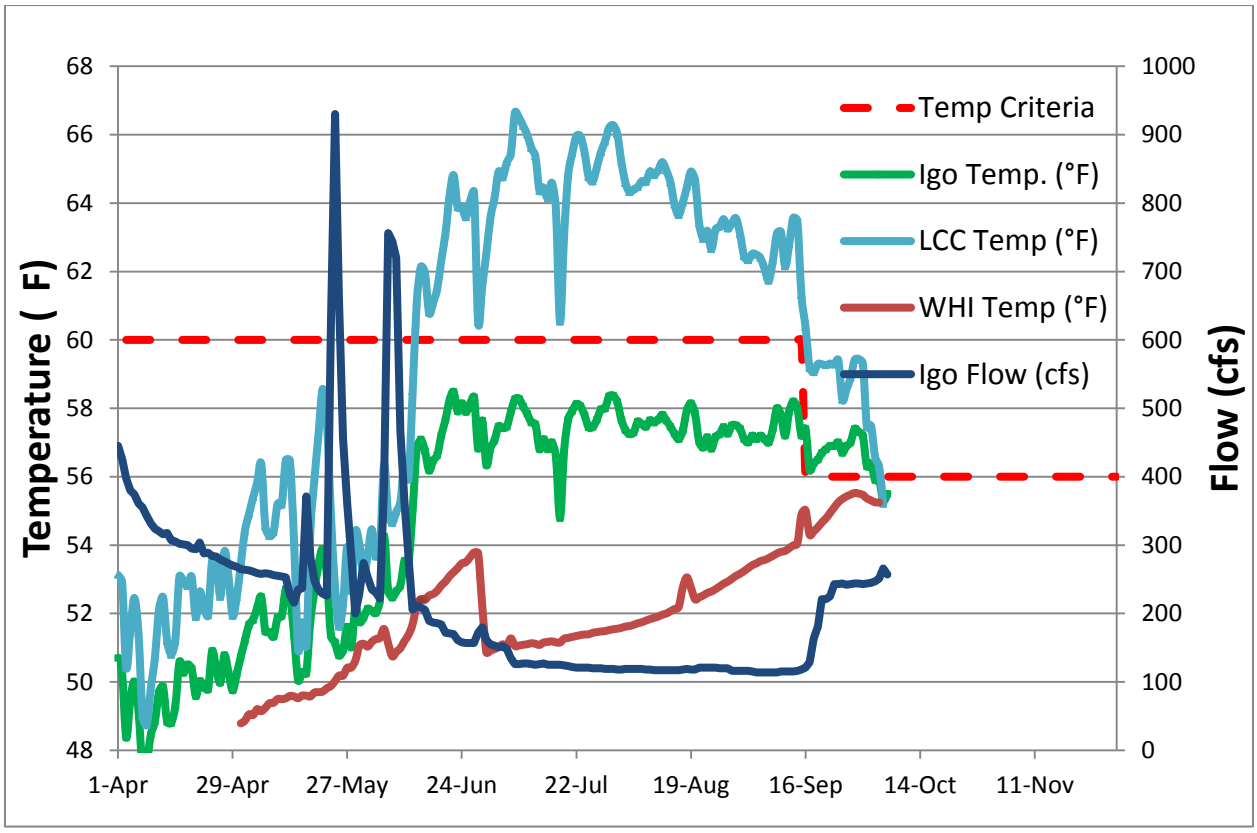


Figure 5. Water temperatures at Whiskeytown Dam (rm 18.1), the Igo gage (rm 10.9), and Lower Clear Creek rotary screw trap (rm 1.7) and flow at the Igo gage in 2011. Temperature criteria from NMFS RPA.

Action I.1.6. Adaptively Manage to Habitat Suitability/IFIM Study Results

Objective: Decrease risk to Clear Creek spring-run and CV steelhead population through improved flow management designed to implement state-of-the-art scientific analysis on habitat suitability.

Action: Reclamation shall operate Whiskeytown Reservoir as described in the Project Description with the modifications in Action I.1 until September 30, 2012, or until 6 months after current Clear Creek salmonids habitat suitability (e.g. IFIM) studies are completed, whichever occurs later.

Results: The FWS began a new IFIM study in 2004. Field work for the project is complete. The results of the study will be contained in 4 reports, 3 of which have been finalized. In 2011, a draft report on fall-run Chinook salmon juvenile rearing study sites in the lower reach was completed and a report on fall-run Chinook salmon spawning study sites in the lower reach was finalized after peer review. Work continues on model bio-validation. The 32 IFIM flow-habitat models from the four reports will be synthesized with population, temperature, and restoration information to provide flow prescriptions that optimize habitat needs for all species, runs and life stages of salmonids in the different reaches of the creek, throughout the year. In 2012, this alternative flow prescription will be proposed to NMFS.

During the March 23rd CCTT meeting, Li-Ming He of NMFS presented his draft proposal "Recommendations for Instream Flow and Water Temperature for Salmonids in Clear Creek" (Recommendations). He sent a revised proposal out to some team members for review.

Recommendations: Review draft and completed IFIM reports in 2012. Working with NMFS and the Clear creek Technical Team, assess if Clear Creek flows shall be further adapted to reduce adverse impacts on spring-run Chinook and steelhead. Evaluate NMFS Recommendations report as it relates to Actions I.1.1. I.1.2. I.1.5. and I.1.6., and implement where appropriate.

Summary of Recommendations: To avoid redundancy and to focus attention, many recommendations to continue implementing actions are not included in this summary.

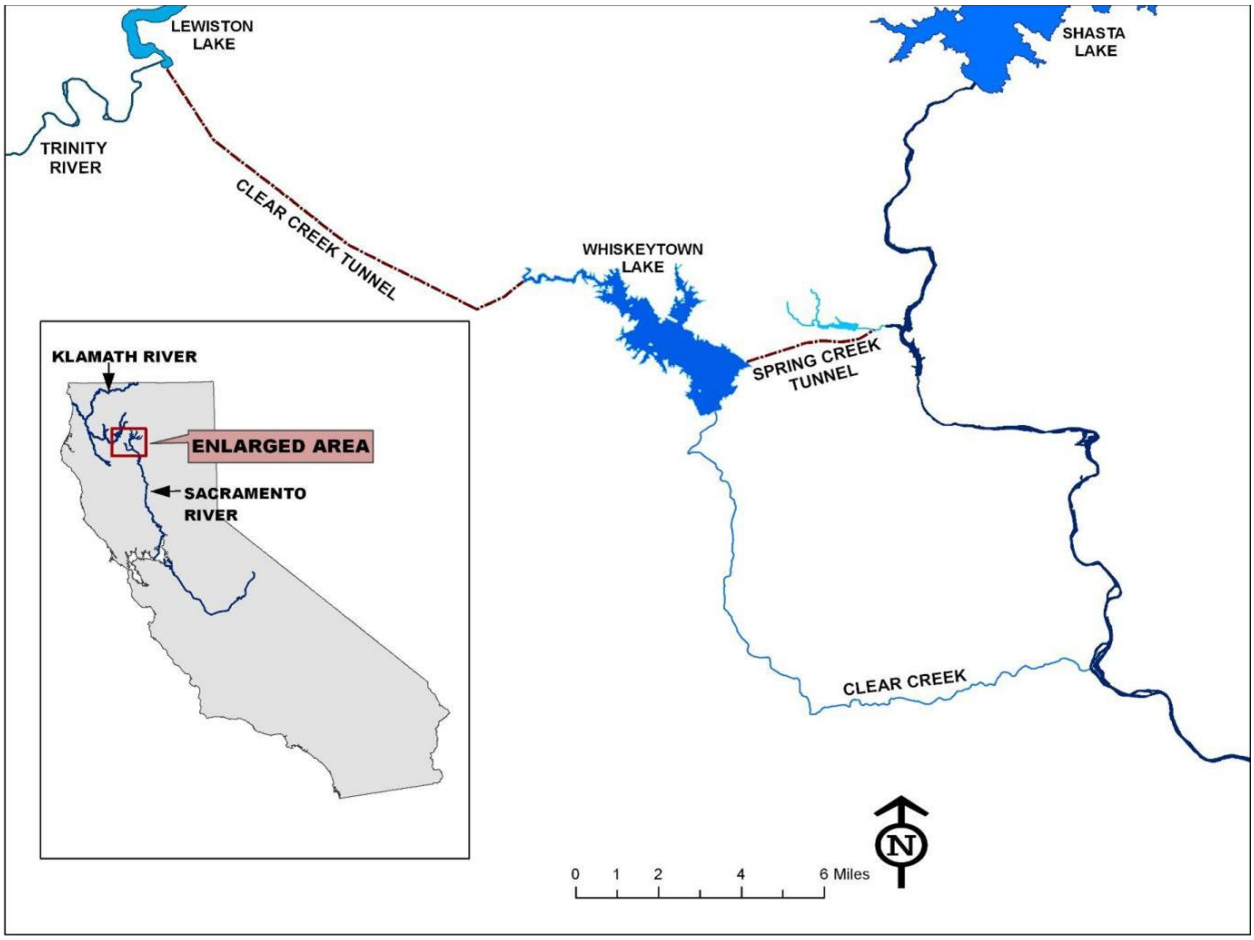
Evaluate the effectiveness of the temperature control curtain in reducing water temperatures in both the Sacramento River and Clear Creek. An evaluation could determine if the curtain was installed successfully, if it is working as designed, if any improvements are needed or warranted, and how much benefit it produces in terms of cold water.

Develop a schedule for improving water temperature modeling to better meet Clear Creek water temperature objectives. Implement the findings that will result in temperature improvements. Consider managing water temperatures further downstream of Igo where the majority of the target fish are located. Reclamation has not identified a schedule for making improvements to modeling water temperatures in Clear Creek. Reclamation may not have fully assessed improvements to modeling water temperatures in Clear Creek.

Evaluate NMFS Recommendations report as it relates to Actions I.1.1. I.1.2. I.1.5. and I.1.6. and implement where appropriate.

Acronyms and Abbreviations

BO	Biological Opinion
CDFG	California Department of Fish & Game
CCTT	Clear Creek Technical team
cfs	Cubic feet per second
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
FWS	U.S. Fish & Wildlife Service
IFIM	Instream Flow Incremental Methodology
NMFS	National Marine Fisheries Service
OCAP	Operations Criteria and Plan
Reclamation	U.S. Bureau of Reclamation
rm	river mile
RPA	Reasonable and prudent alternative



Map 1. Location of Lower Clear Creek in Northern California, showing Trinity, Whiskeytown, and Shasta Reservoirs and related CVP facilities.